MUID Efficiency
HV method

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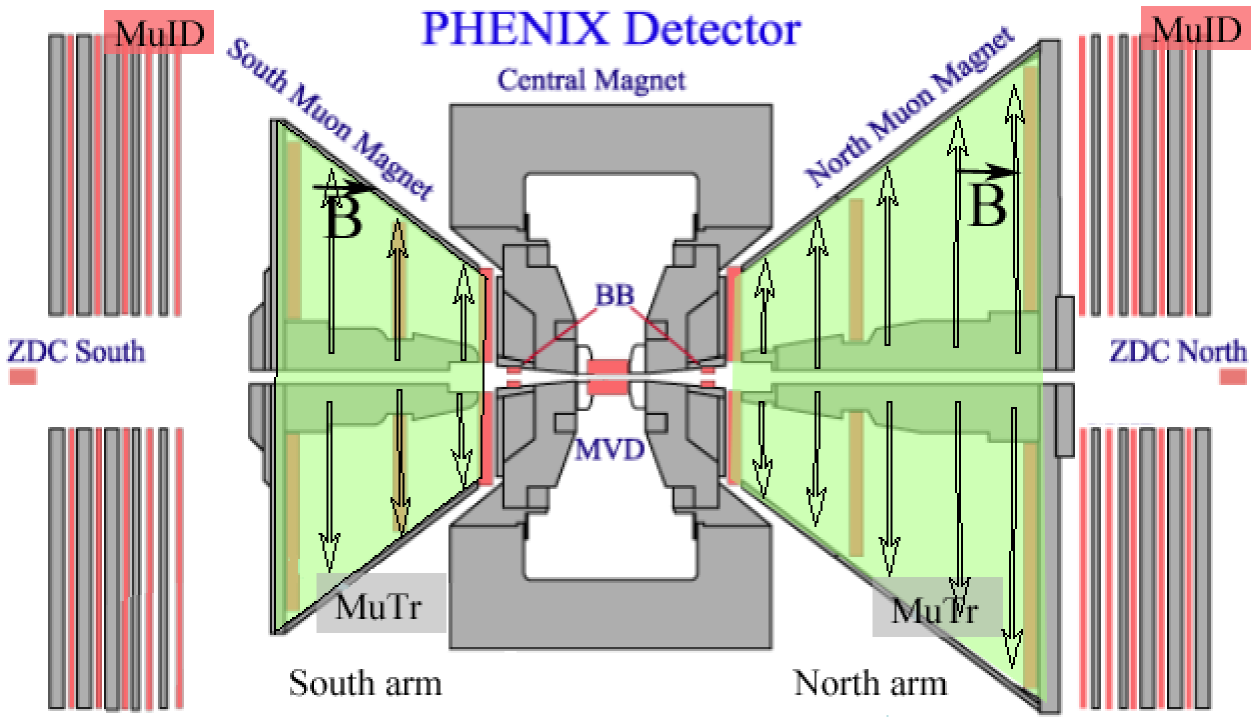
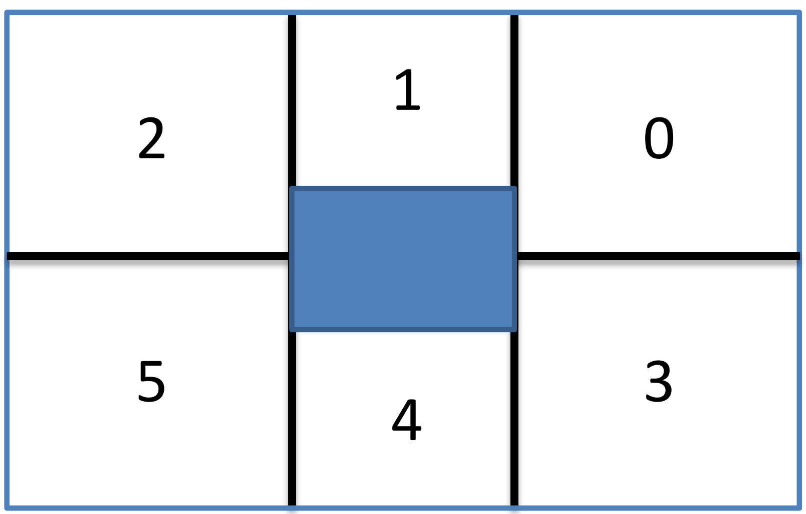
MuID's geometry



- MuID, lying behind MuTr, is a five-layered detector used to determine which of the incident particles are muons.
- Each layer, called a gap, is filled with transversely-oriented Iarocci tubes.

MuID's geometry (2)

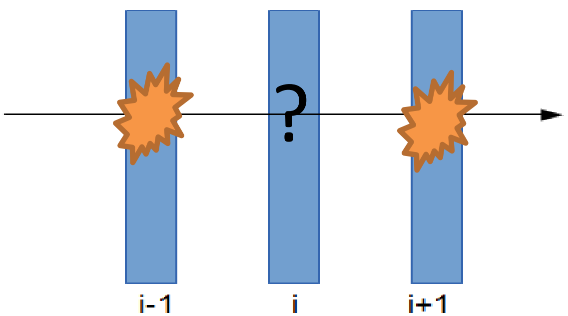
- Each gap consists of two planes : one where the tubes are horizontally oriented and the other where the tubes are vertically oriented.



- These planes are then further divided into six panels

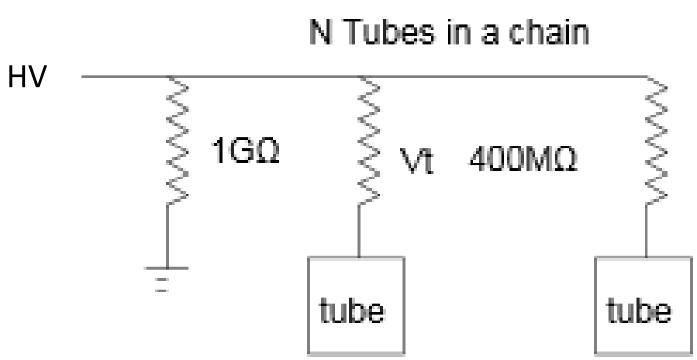
MuID’s efficiency

- As of now, two methods exist to determine MuID’s efficiency :
  - The data-driven method



Efficiency is determined using the tracks registered in the previous and in the next gap

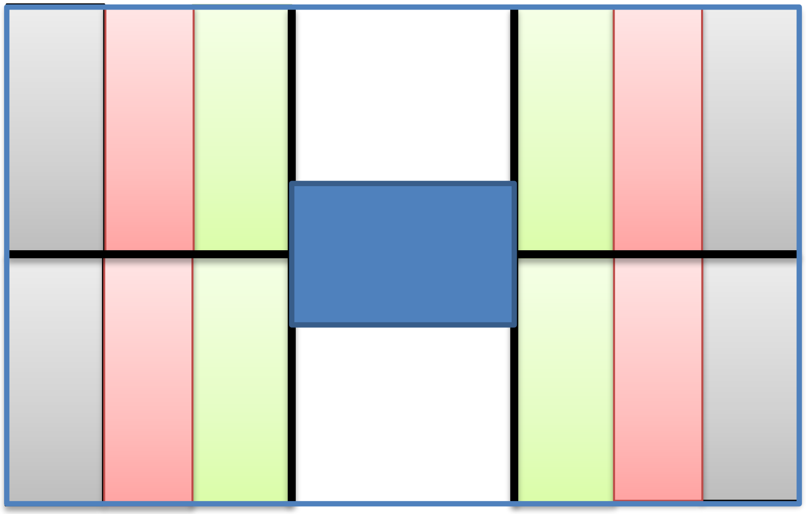
  - The HV method



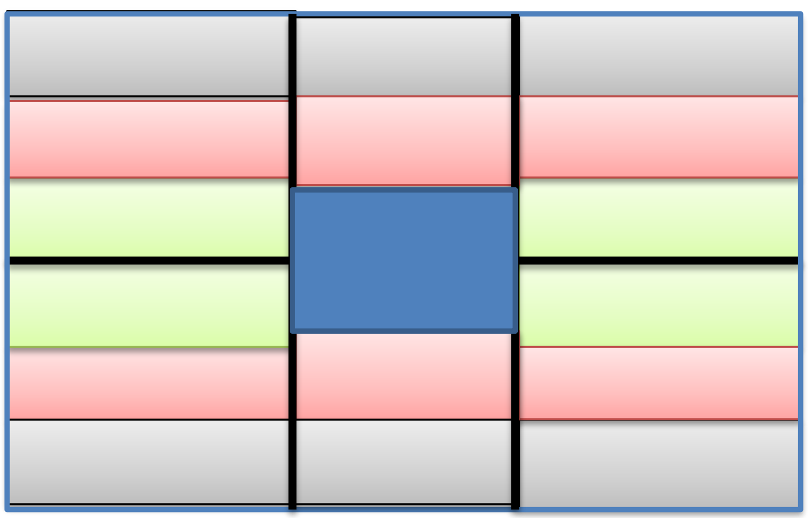
Uses an empirical formula relying on the current drawn from the HV supplies by the different tube chains :

$HV_{eff} = HV - R * I_{drawn}$

Understanding MuID's HV supplies



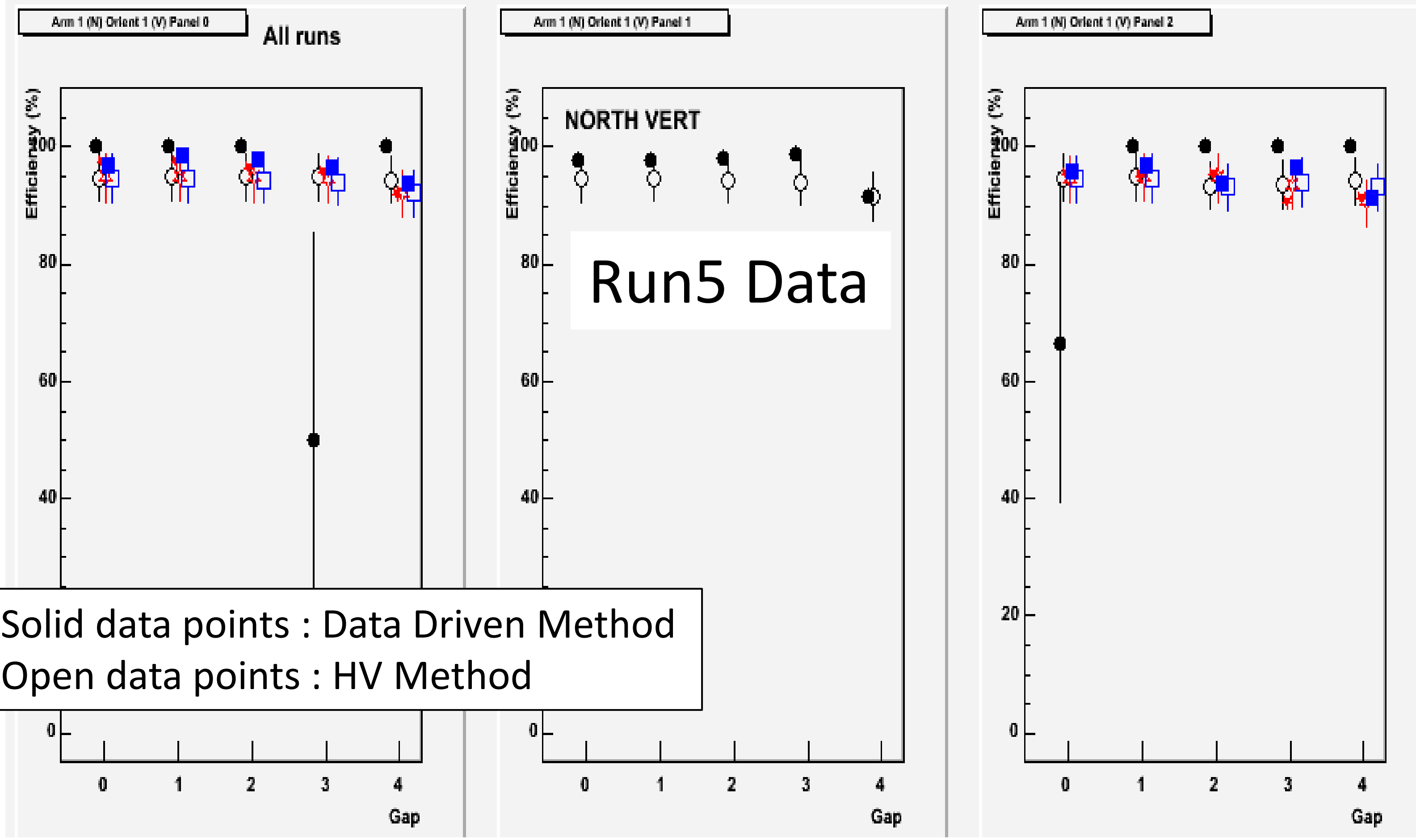
Vertical plane



Horizontal plane

- Each MuID HV channel consists of two individual tubes.
- These tubes are part of two different HV chains which typically serve about 20 tubes.
- Two HV chains that serve the same channel make a HV group.
- On the left, for each panel we have :
- Grey : group 1
- Red : group 2
- Green : group 3

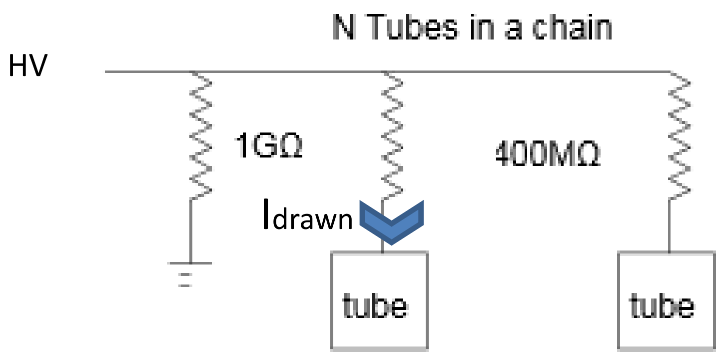
Consistency between 2 methods

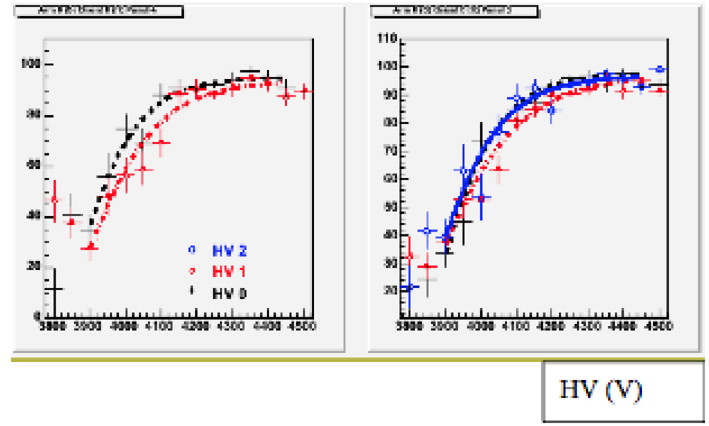


Solid data points : Data Driven Method
Open data points : HV Method

- Two methods demonstrated consistent efficiencies.
- Is this still valid under high rate circumstances? MUID was operated in much lower efficiency in Run13.

HV method





- The information we have access to is the total current drawn by the N tubes chain, $\mathbf{I_{tot\ (Raw)}}$, from which we extract the baseline current $\mathbf{I_{tot\ (baseline)}}$ to get $\mathbf{I_{tot} = I_{tot\ (Raw)} - I_{tot\ (baseline)}}$

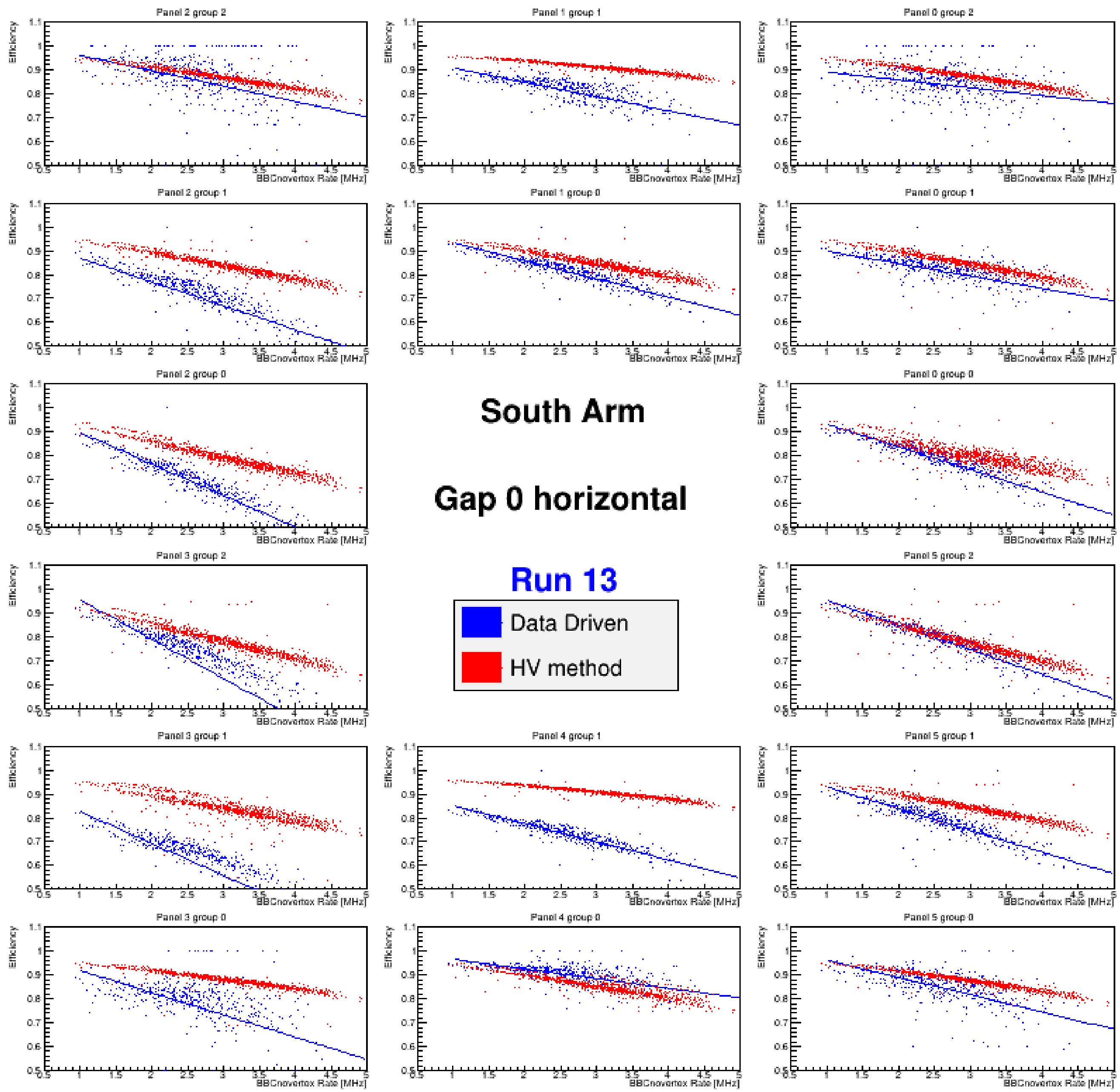
- Assuming that all tubes draw the same amount of current, we need to know the number of active tubes to determine the amount of current drawn per tube : $\mathbf{I_{drawn} = I_{tot} / N_{act}}$, where $\mathbf{N_{act} = N - N_{broken}}$

- To get Hveff we then use : $\mathbf{HV_{eff} = HV - R * I_{drawn}}$

- Which then leads us to the efficiency using the empirical formula that was determined in 2004 :

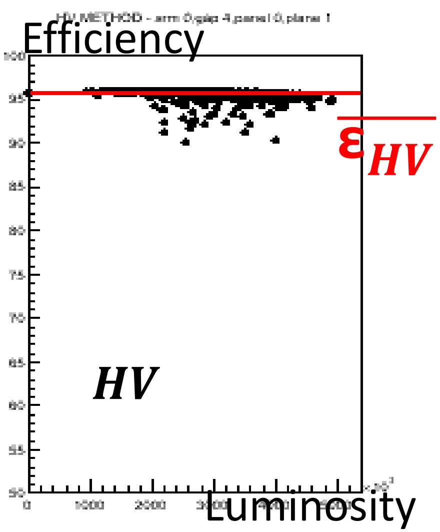
$$\boldsymbol{\varepsilon = 0.96 * (1 - 2.4e\text{-}6 * HVeff^2)}$$

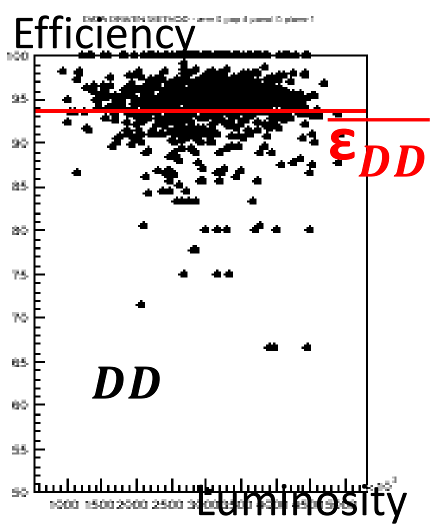
Resulting efficiencies of HV and DD methods

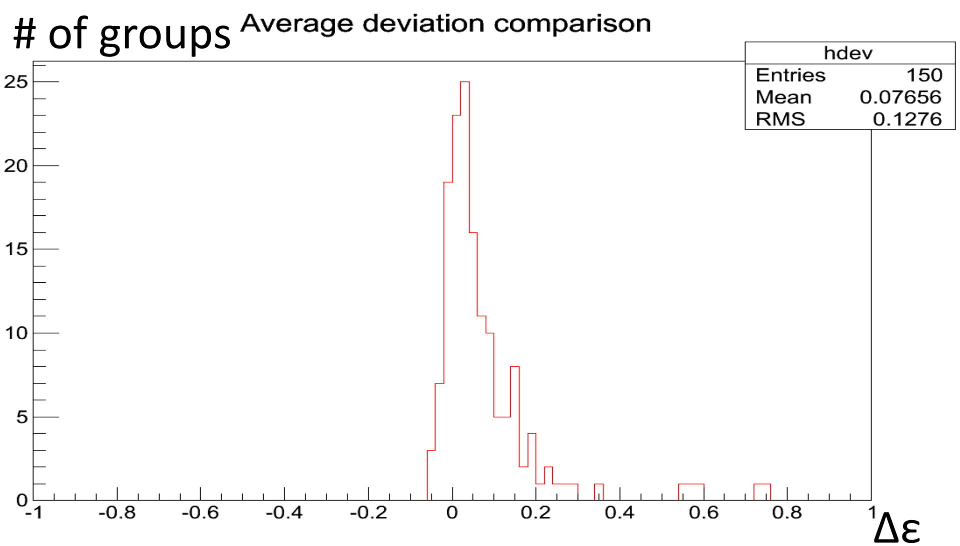


Comparing HV and DD methods (1)

- The average deviation between both methods can be evaluated by : $\Delta\varepsilon = \dfrac{\overline{\varepsilon_{HV}} - \overline{\varepsilon_{DD}}}{\overline{\varepsilon_{HV}}}$

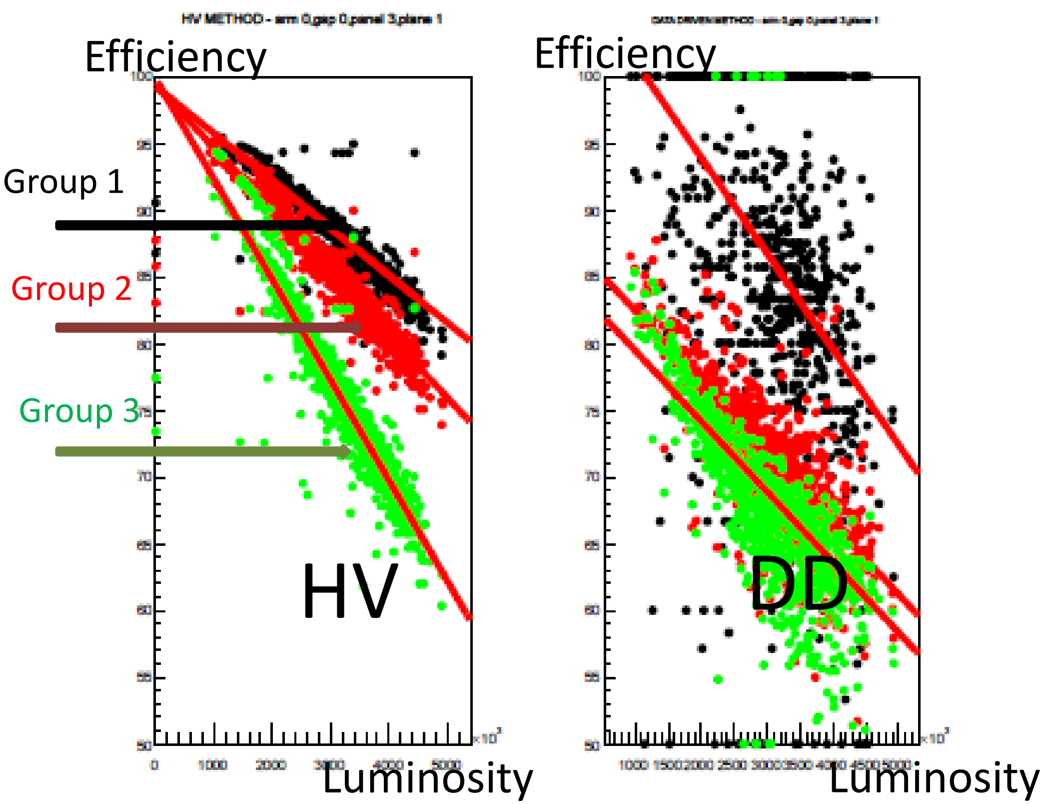


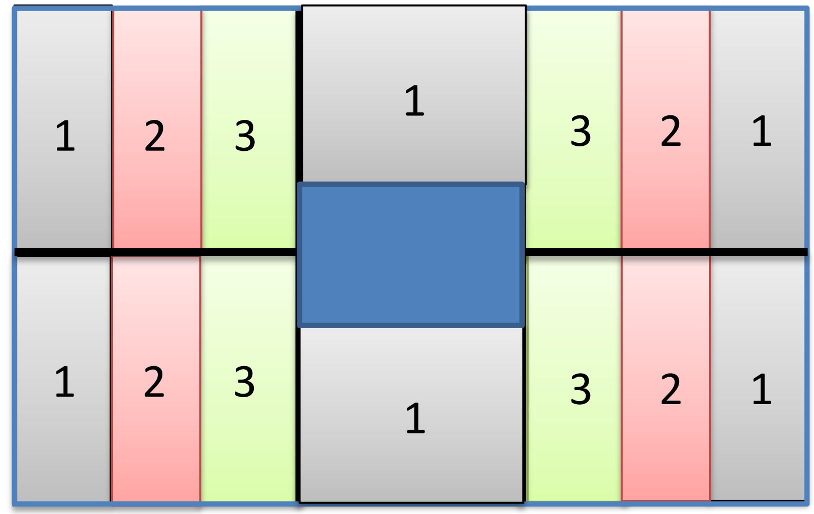




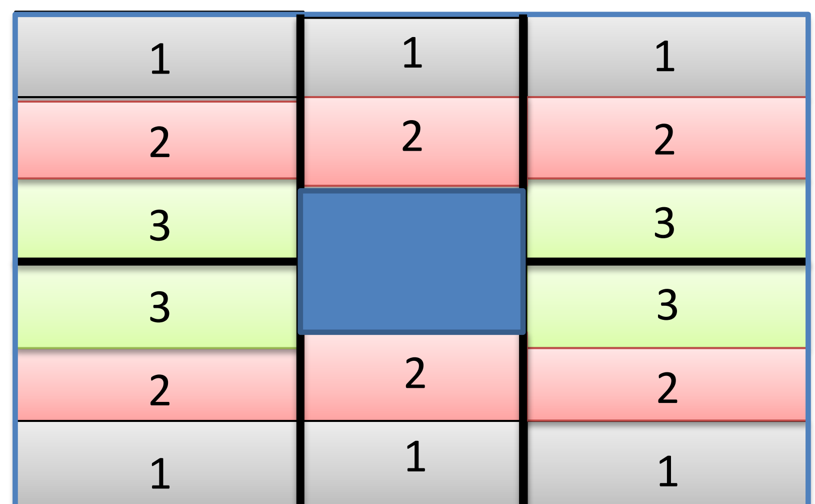
- This histogram shows us that Δε is positive in most cases : HV method efficiency has a tendency to be higher than the DD one. As we want both method to agree, we have to investigate on this.
- The first step is to check the geometry consistency.

Comparing HV and DD methods (2)



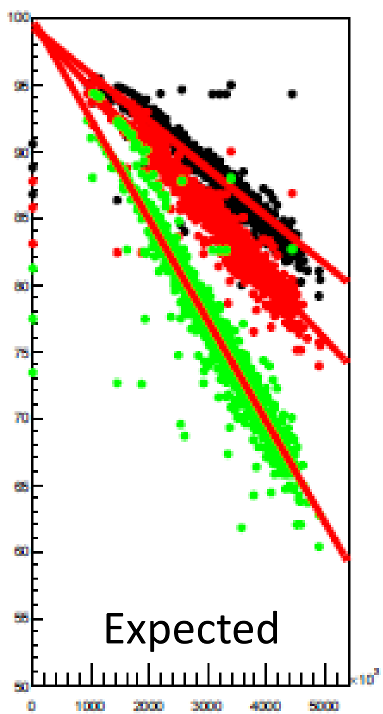


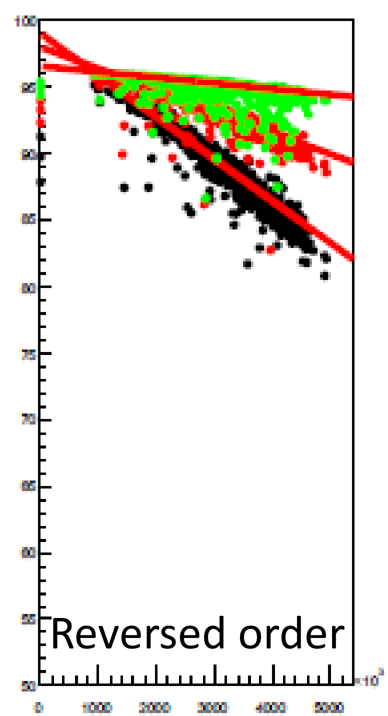
Group numbering

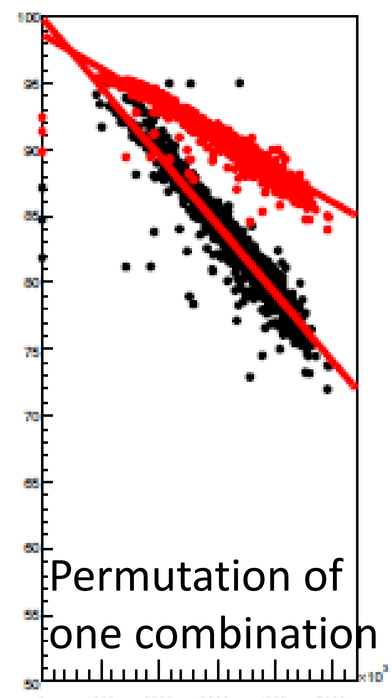


Group order

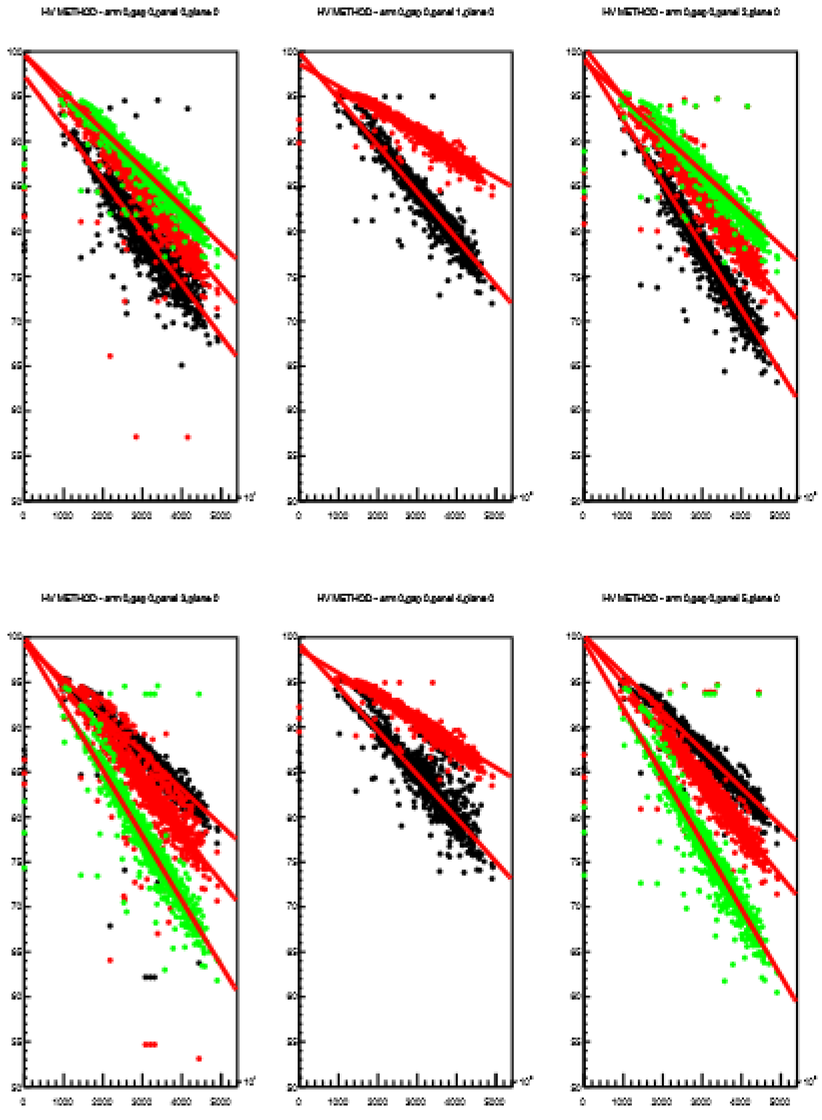
- Because they have higher hit rates, we expect groups closer to the beamline to have generally lower efficiencies.
- However some samples don’t behave as expected :



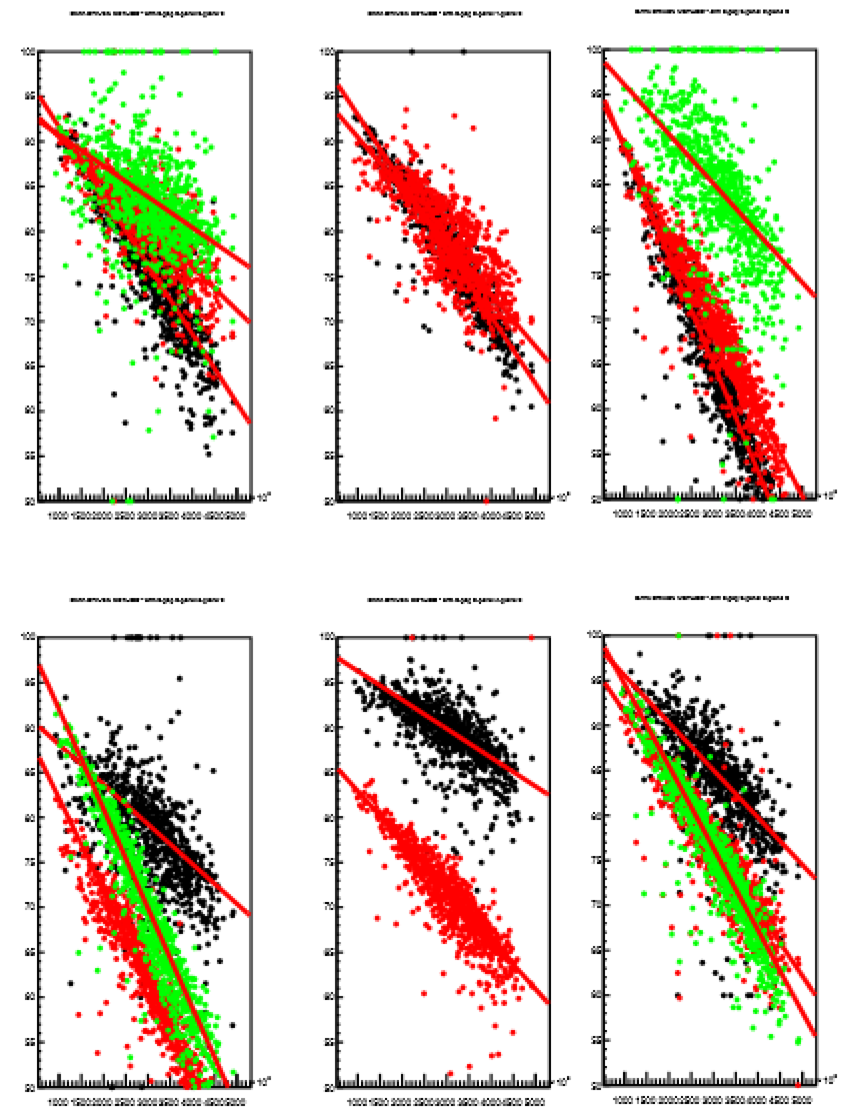




Results for the horizontal plane of gap 0



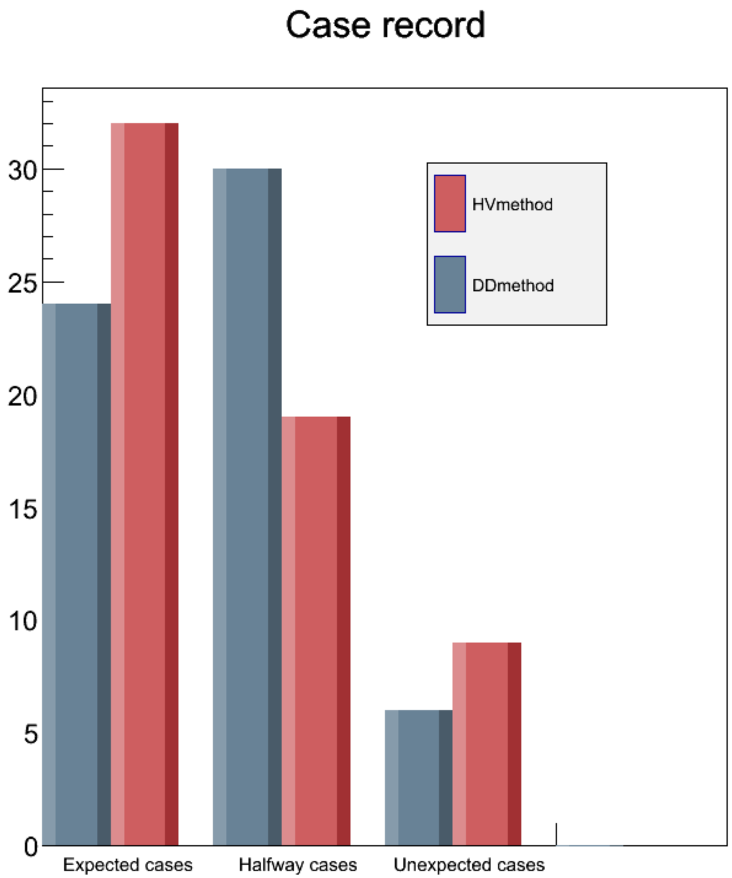
HV method



DD method

Group order (3)

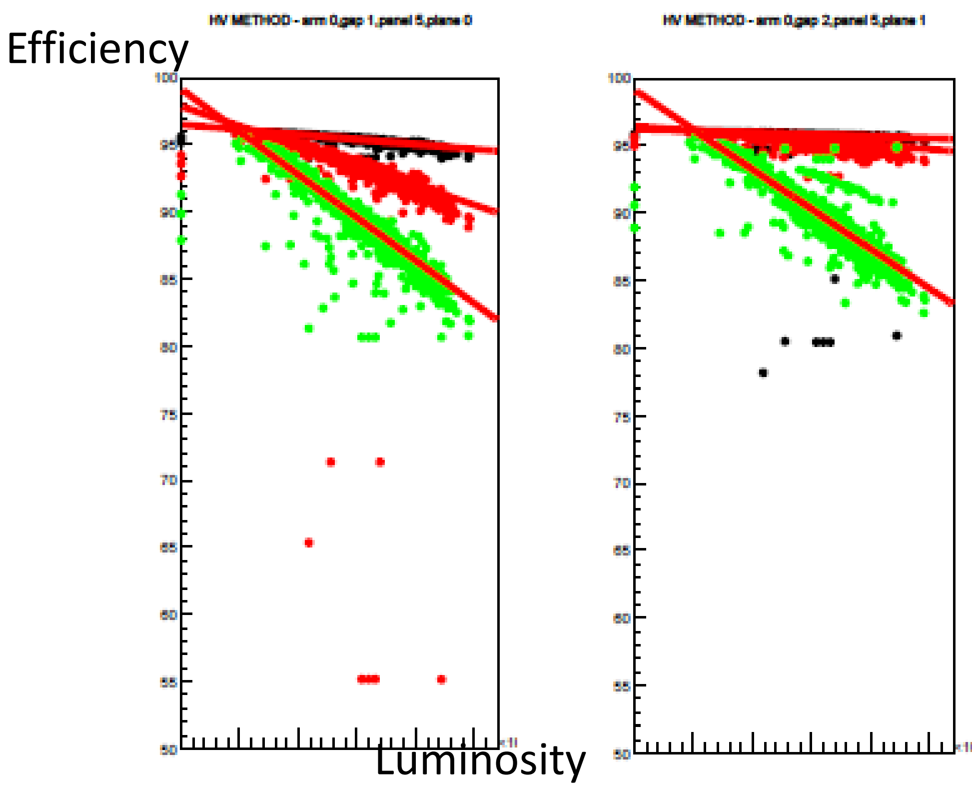
- We decided to classify group orders into 3 categories :
  - the expected group order,
  - the halfway order : two of the three groups are reversed,
  - the unexpected order : the three groups are reversed.



- This histogram shows the number of panels per group order.
- HV and DD methods disagree on the group order for 23 out of 60 panels.

Group order (4)

- However, though the order is clear for most cases, it has been pointed out to us that there are panels where the efficiencies of both groups overlap each other, making the order, determined with fits, quite dubious.

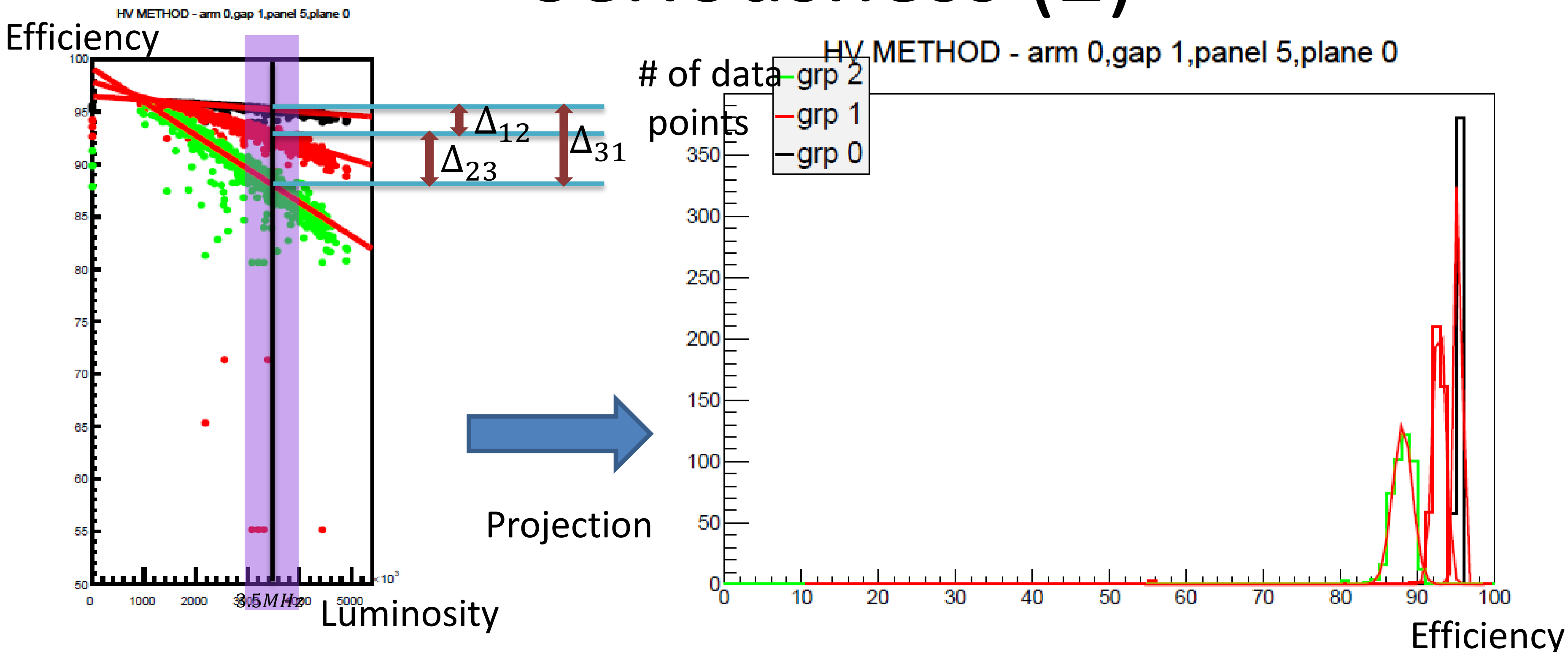


Seriousness (1)

- To better study this group order, we need to find a way to weight how relevant each panel is.

- The weight we chose to assign to our panels is called the « seriousness », and takes into account the spread of the distributions as well as the distance between them.

Seriousness (2)

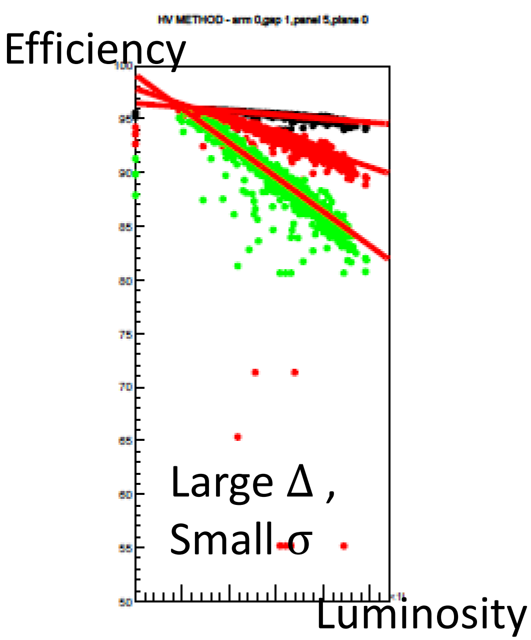


- We projected data points which luminosities were included in a 3 to 4MHz range on a vertical plane.

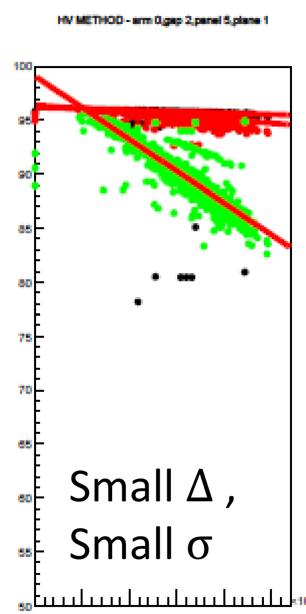
- This gives us 3 gaussian curves which, after a fit, gets us the spread of the distributions through their sigma parameter : σ_1, σ_2 and σ_3

Seriousness (3)

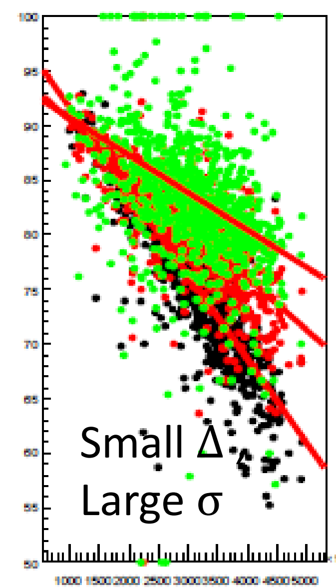
- Finally, the « seriousness » S of a panel is given by
  - » $S = \frac{|\Delta_{12}|}{\sigma_1 + \sigma_2} + \frac{|\Delta_{23}|}{\sigma_3 + \sigma_2} + \frac{|\Delta_{31}|}{\sigma_1 + \sigma_3}$
- S increases with the distance between the distributions and shrinks with their respective spreads.



$S = 8.66239$

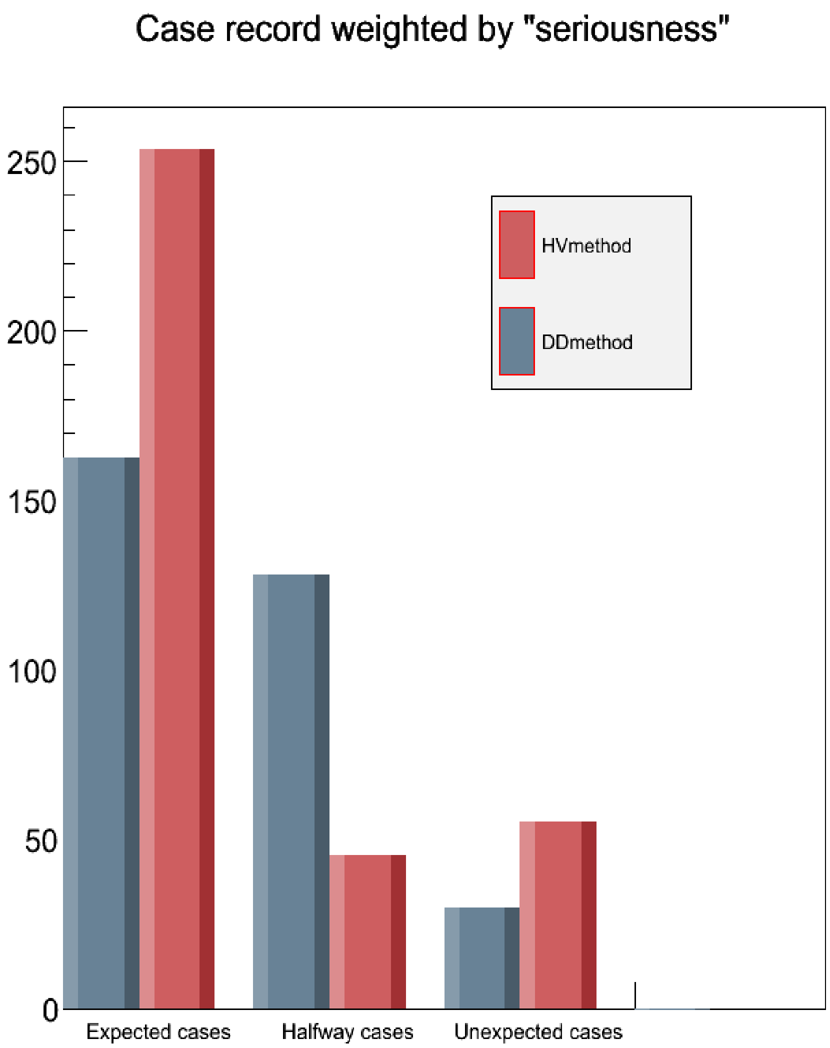


$S = 7.63904$



$S = 5.08619$

Weighted group order



- To plot this histogram, we weighted each panel by its seriousness.
- This can be used as a reference for future alterations on both methods.

- We introduced a quantitative way to evaluate the consistency expected from the geometry, and it can also be used to quantify the consistency between both methods.

Future plans

- Currently we're running consistency checks (as expected from rates) :
  - $\varepsilon_{grp1} > \varepsilon_{grp2} > \varepsilon_{grp3}$?
  - $\varepsilon_{gap0} < \varepsilon_{gap1} < \varepsilon_{gap2}$?

- We also plan to apply some corrections to allow a fairer comparison for both methods :

1. Average (HV) vs. Time-biased (DD) efficiency
2. Average (HV) vs. Geometrically biased (DD) efficiency
3. $\varepsilon = 0.96 * (1 - 2.4e\text{-}6 * HV_{eff}^2)$ function may have changed over time and may no longer be valid

Future plans (2)

- Our current question is : why $\overline{\varepsilon_{HV}} > \overline{\varepsilon_{DD}}$?
- Second and third correction may bring $\overline{\varepsilon_{HV}}$ down, but we're still not sure of how the first one will affect it.

- We'll get the updated ε = f(Hv$_{eff}$) function with new measurements in July.
- These corrections will have to be done by September, which is the deadline for my Master's thesis.